# Searching for the tau neutrino magnetic moment

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# Outline

- Characteristics of a magnetic moment interaction
- Search methods
- High efficiency search
- Conclusions

# Characteristics of a magnetic moment interaction

- Neutrino-electron interaction
  - $\nu + e \rightarrow \nu + e$
  - no hadronic activity
- cross section decreases as 1/T
  - T is the electron energy
- search for single, low-energy electrons

# Method 1: Search for special events

- Single track exiting the emulsion, very straight forward
  - an electron that has not showered
- Advantage:
  - clean signal
- Disadvantage:
  - small efficiency
  - the emulsion cannot help

# Method 2: high efficiency search

- Find all events with electron-signature
  - use the MC to define event-shape parameters and reduce background
- Advantage:
  - high efficiency
    - If there is only one event, we will not miss it.
- Disadvantage:
  - signal and background are not easily separated

# Method 3: other searches

- Take advantage of $\sigma \sim 1/T$, look for keV electrons:
  - excessive noise in the emulsion
    - very black
    - a lot of short track stubs
  - excessive noise in the SFT
    - beam-on pedestal different from beam-off pedestal
  - unexplainable beam-on pulseheight in the EMCAL (only in the center)
- not trigger dependent

# Method of choice: 2; high efficiency search

- Spectrometer analysis:
  - Reduce candidate event sample
    - eliminate $\nu_\mu$ CC interactions → easy, muon track
      - removes 90% of the $\nu_\mu$ CC interactions
    - eliminate $\nu_e$ CC interactions → a lot of EM energy
      - removes 90% of the $\nu_e$ CC interactions
    - eliminate NC interactions → only hadronic activity
      - removes (90)% of the NC interactions
    - eliminate $\nu_\tau$ CC interactions → each of the above
  - prepare all candidates for emulsion scanning
    - $\nu_\tau$ CC→hadrons and NC enriched

# High Efficiency Search

- Emulsion analysis
  - magnetic moment interactions will not be found
    - CS scan requires track of >50mrad
    - net scan requires at least 3 tracks from the vertex
  - if a candidate event is scanned and the vertex is not found, then
    - Why? Is an important question
    - can we determine if one of the tracks in the event is not an electron?

# Conclusions

- A high-efficiency search for the tau neutrino magnetic moment requires both spectrometer and emulsion information
- I will produce a list of events with prediction and send it to Nagoya
  - at first only period 4
  - later for all periods
- I will obtain a limit for the magnetic moment from all three methods